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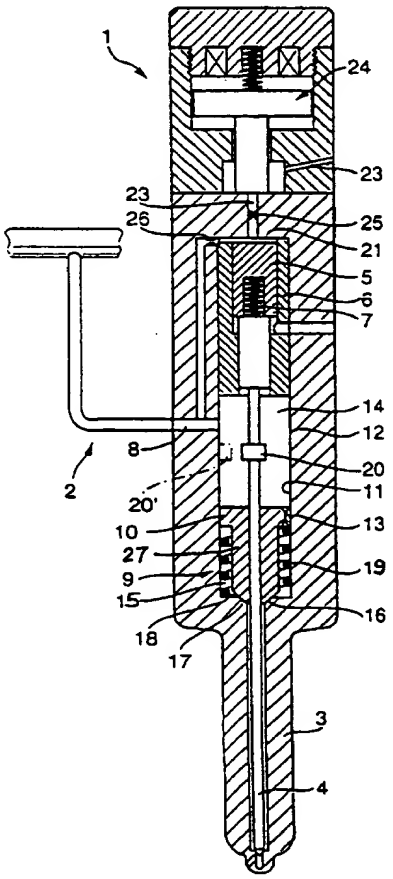
(54) I.c. engine fuel injection valve with integral flow-limiting valve

(57) The fuel injection valve 1, for a common-rail fuel injection system 2, contains a nozzle needle 4 and an electrically driveable control valve 24, by means of which the injection valve 1 can be connected, for the purpose of controlling the injection process, to a relief line 23. The fuel injection valve 1 contains a flow-limiting valve 9, which limits a maximum fuel-flow quantity, in the form of an integral retraction piston 27 which can be urged by excess flow against a valve seat 17 counter to the force of a compression spring 18. The retraction piston 27 has a collar 10 with a throttled passage 13 between upper and lower pressure spaces 14, 15 and is guided for axial displacement by nozzle needle 4 between the valve seat 17 and a travel-limiter 20 or 20' arranged in the injection valve. The invention minimizes the fuel volume enclosed between the flow-limiting valve and the needle seat.



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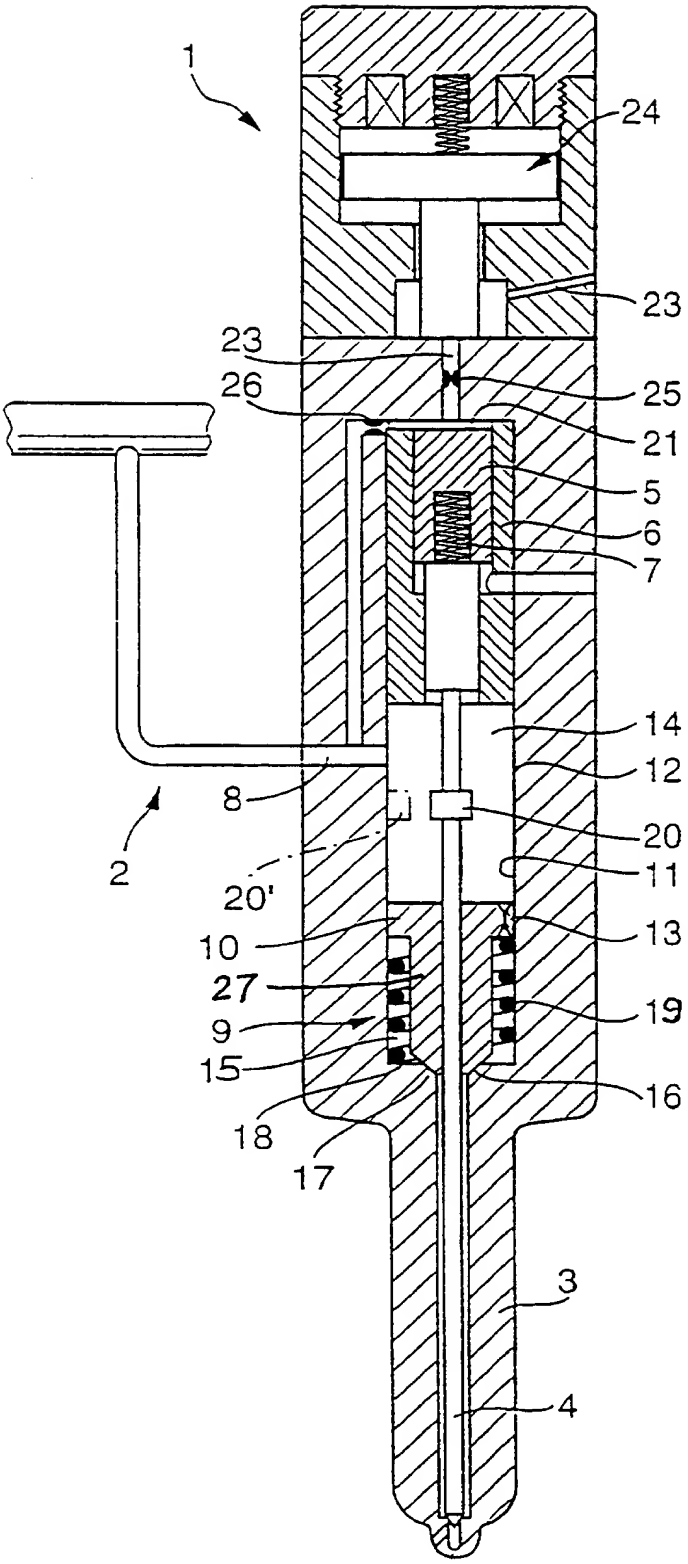

Fuel injection valve for an internal combustion engine

The invention relates to a fuel injection valve for a fuel injection system for an internal combustion engine having a high-pressure pump for feeding the fuel via a fuel-feed line to the injection valve containing a nozzle needle.

Such a fuel injection system having a high-pressure pump is known from EP 0 678 668 A2. This high-pressure pump feeds the fuel via a fuel-feed line into a supply line (common rail), which acts as a high-pressure accumulator and supplies all the solenoid-controlled injection valves on the internal combustion engine.

The fuel injection system is provided with flow- quantity-limiting valves, which are connected into injection lines running between the supply line and the respective injection valves. These flow-limiting valves serve to limit the flow quantity, or close off the injection line, when an acceptable flow quantity has been exceeded, which may occur as a result of the nozzle needle jamming, fractures to the nozzle needle or damage to the high-pressure line.

As a result of such measures, injection valves and/or fault-free parts of lines which are operating satisfactorily can continue to be provided with fuel and emergency operation can thus be maintained.

The present invention seeks to improve a fuel injection system of the type referred to in the first paragraph with its flow-quantity-limiting valves to such an extent that the fuel volume enclosed between the flow-quantity-limiting valve and the needle seat is minimized.

According to the present invention there is provided a fuel injection valve for a fuel injection system for an internal combustion engine having a high-pressure pump for continuously feeding the fuel via a fuel-feed line to the injection valve, which contains a nozzle needle and which has an electrically driveable control valve by means of which the injection valve is connectable, for the purpose of controlling the injection process, to a relief line, as well as having a flow-limiter, which limits a maximum fuel-flow quantity, is provided with a throttle point and is adapted to be pressed, as a retraction piston, onto its valve seat counter to the spring force of a compression spring, wherein the retraction piston, which comprises a flow-limiter, is integrated in the injection valve and, surrounding the nozzle needle, is

guided in an axially displaceable fashion by said nozzle needle between the valve seat of the retraction piston and a travel-limiter arranged in the injection valve.

Preferably, the travel-limiter is a needle-side stop which is formed by an external collar on the nozzle needle.

Alternatively, the travel limiter is a nozzle-body-side stop formed by a projection on an internal wall.

In a preferred embodiment, the retraction piston has, at its end facing the control valve, an external collar, which contains the throttle point and is at the same time a supporting face for one of the ends of the compression spring, while the other end of the spring is supported on a pressure shoulder in the nozzle body, said pressure shoulder being located in the region of the valve seat.

In this case, the retraction piston may be of truncated-cone-shape at its end remote from the control valve, and the valve seat has an appropriately matched, conical seat face in the nozzle body.

The particular arrangement of the retraction piston designed as a flow-limiter results in a minimum fuel volume downstream of this flow-limiting valve so that, in the case of a fracture to the nozzle cap, only the previously enclosed fuel quantity between the flow-limiting valve and the needle seat of the nozzle needle is suddenly freed, which means that this minimum destructive volume cannot cause engine damage. In addition, the limited quantity can be configured more precisely since leakage quantities pass upstream of the flow-limiting valve, namely at the needle shaft, at the control or closing piston or there is leakage through the outflow throttle connected to the low-pressure side.

GB 2 043 777 A discloses a spring-loaded retraction piston which contains a throttle line and is integrated in the injection valve, but said piston produces a continuous high-pressure connection to the nozzle needle. This retraction piston can be actuated by a travel-control device, has an operative connection to a valve slide and serves as a metering element for precisely controlling the quantity of fuel to be injected.

In the case of a nozzle cap fracture in known embodiments with a flow-limiting valve between the common supply line and the respective solenoid-controlled injection valves, the engine is no longer protected owing to the instantaneously present,

large injection quantities and/or as a result of the acceptable flow quantity being exceeded.

An embodiment of the invention is illustrated in the drawing and will be explained in more detail hereinafter.

The drawing shows a solenoid-controlled fuel injection valve 1 for a fuel injection system 2, operating according to the common-rail system, of a multi-cylinder internal combustion engine is composed essentially of an elongated nozzle needle 4 guided in the nozzle body 3, a control piston or closing piston 5 which bears against the rear of the nozzle needle 4 and is longitudinally displacably guided counter to the action of a compression spring 7 in a casing 6 which is axially secured in the nozzle body 3, and additionally of a fuel inflow line 8 and a flow-limiting valve 9.

The retraction piston 27 of the flow-limiting valve 9, which surrounds the nozzle needle 4 which serves at the same time as a guide, has at the top an external collar 10 which slides on the inner wall 11 of a cylindrical recess 12 of the nozzle body 3.

The external collar 10 has a throttle point 13 with defined throttle cross-section, which throttle point 13 serves as the only flow connection between a pressure space 14 located at the top, into which pressure space 14 the fuel inflow line 8 opens, and a pressure space 15 which is located at the bottom and which extends downstream of the external collar 10 as far as the valve seat of the nozzle needle 4.

The retraction piston 27 is of truncated-cone-shaped design at its end remote from the external collar 10 and interacts with an appropriately matched, conical seat face 16 of the valve seat 17 in the nozzle body 3. A compression spring 19, which holds the retraction piston 27 against a stop, is arranged between the external collar 10 and a pressure shoulder 18 in the region of the conical seat face 16. This stop is formed either by means of a projection 20 on the nozzle needle 4 or by means of a projection 20' in the cylindrical recess 12 of the nozzle body 3.

The closing piston 5 delimits a control space 21 into which a feed-line 22, which branches off from the fuel inflow line 8, leads, and from which a relief line 23, which can be connected to the low-pressure side (not illustrated in more detail) by means of an electro-magnetically actuated control valve 24 or solenoid valve, leads away.

The relief line 23 contains an outflow throttle 25 upstream of the control valve 24, and the feed-line 22 contains an inflow throttle 26.

The method of operation of the flow-limiting valve and retraction piston:

The retraction piston 27 which acts as a flow-limiter moves in the direction of the tip of the nozzle counter to the spring force whenever injection occurs, but, during normal operation, does not arrive at its valve seat. The flow connection is thus maintained. In the injection interval, the retraction piston 9 is moved back into its starting position against the stop 20 or 20' by the compression spring 18.

However, if a specific, operationally suitable injection quantity is exceeded, the retraction piston 9 is pressed onto its valve seat 17. The flow connection is interrupted and the engine protected.

Claims

1. A fuel injection valve for a fuel injection system for an internal combustion engine having a high-pressure pump for continuously feeding the fuel via a fuel-feed line to the injection valve, which contains a nozzle needle and which has an electrically driveable control valve by means of which the injection valve is connectable, for the purpose of controlling the injection process, to a relief line, as well as having a flow-limiter, which limits a maximum fuel-flow quantity, is provided with a throttle point and is adapted to be pressed, as a retraction piston, onto its valve seat counter to the spring force of a compression spring, wherein the retraction piston, which comprises a flow-limiter, is integrated in the injection valve and, surrounding the nozzle needle, is guided in an axially displaceable fashion by said nozzle needle between the valve seat of the retraction piston and a travel-limiter arranged in the injection valve.

2. A fuel injection valve according to Claim 1, wherein the travel-limiter is a needle-side stop which is formed by an external collar on the nozzle needle.

3. A fuel injection valve according to Claim 1, wherein the travel limiter is a nozzle-body-side stop formed by a projection on an internal wall.

4. A fuel injection valve according to Claim 1, wherein the retraction piston has, at its end facing the control valve, an external collar, which contains the throttle point and is at the same time a supporting face for one of the ends of the compression spring, while the other end of the spring is supported on a pressure shoulder in the nozzle body, said pressure shoulder being located in the region of the valve seat.

5. A fuel injection valve according to Claim 4, wherein the retraction piston is of truncated-cone-shape at its end remote from the control valve, and the valve seat has an appropriately matched, conical seat face in the nozzle body.

6. A fuel injection valve for a fuel injection system substantially as described herein with reference to, and as illustrated in, the accompanying drawing.

Amendments to the claims have been filed as follows

Claims

1. A fuel injection valve for a fuel injection system for an internal combustion engine having a high-pressure pump for continuously feeding the fuel via a fuel-feed line to the injection valve, which contains a nozzle needle in a nozzle body and which has an electrically driveable control valve by means of which the injection valve is connectable, for the purpose of controlling the injection process, to a relief line, said fuel injection valve also having a flow-limiter, which limits a maximum fuel-flow quantity and which is provided with a throttle point adapted to be pressed onto a valve seat, counter to the spring force of a compression spring, wherein the flow-limiter is designed as a retraction piston which is integrated in the injection valve and which surrounds the nozzle needle, said retraction piston being guided in an axially displaceable fashion by said nozzle needle, between the valve seat of the retraction piston and a travel-limiter arranged in the injection valve.

2. A fuel injection valve according to Claim 1, wherein the travel-limiter is a needle-side stop which is formed by an external collar on the nozzle needle.

3. A fuel injection valve according to Claim 1, wherein the travel limiter is a nozzle-body-side stop formed by a projection on an internal wall of the nozzle body.

4. A fuel injection valve according to Claim 1, wherein the retraction piston has, at its end facing the control valve, an external collar, which contains the throttle point and is at the same time a supporting face for one of the ends of the compression spring, while the other end of the spring is supported on a pressure shoulder in the nozzle body, said pressure shoulder being located in the region of the valve seat.

5. A fuel injection valve according to Claim 4, wherein the retraction piston is of truncated-cone-shape at its end remote from the control valve, and the valve seat has an appropriately matched, conical seat face in the nozzle body.

6. A fuel injection valve for a fuel injection system substantially as described herein with reference to, and as illustrated in, the accompanying drawing.

The Patent Office

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Claims searched:	1 to 6	**Date of search:**	27 January 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): F1B (B2JCB)

Int Cl (Ed.6): F02M 63/02

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	EP 678668 A2 (Robert Bosch)	
A	GB 2043777 A (Robert Bosch)	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.